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ABSTRACT

Project S.C.A.M.P. (Science, Computer and Mathematics Professions) is a year-long program designed to encourage the mathematical and scientific talents and interests of rural gifted junior high school students. Students participated in a 3-week residential summer camp at the University of Virginia and completed computer-based classes in geometry and mathematical modeling. Professionals from different scientific disciplines gave demonstrations and discussed their careers and the academic preparation necessary for their positions. Field trips were scheduled to allow the students to interact with and observe scientists in their work places. As a year-long project, each student created a computer simulation for a scientific topic with the help of a university mentor. Follow-up activities encouraged students to share their knowledge with teachers and peers through demonstration of their projects. Between formal meetings, students communicated with one another, the camp staff, and mentors through Virginia PEN (Public Education Network), a computer network. Three Saturday meetings were planned throughout the year to maintain interest of students and support of parents. A pretest and posttest were administered and results indicated an improvement in participants' geometric knowledge. This model appears to alleviate problems such as isolation, unchallenging curriculum, and a lack of resources experienced by academically talented rural students. (LP)

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Presenter: Marguerite M. Mason
Co-Presenter: Walter Bruce Mason
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Project S.C.A.M.P. (Science, Computer, and Mathematics Professions): A Young Scholars Program for Academically Talented Rural Youth

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Project S.C.A.M.P. (Science, Computer, and Mathematics Professions): A Young Scholars Program for Academically Talented Rural Youth

The Problem

Academically talented rural students, especially those who do not have easy access to gifted programs and/or computer and laboratory facilities within their school districts, are often underserved. They frequently feel isolated and unchallenged. They don't even consider the possibility of a scientific career and fail to take the high school courses essential for competing successfully in college science and mathematics courses.

There are many problems associated with serving highly academically talented students adequately in a rural setting. There is often a lack of physical resources such as laboratories, computers, libraries, and just plain places to explore. As one seventh grade students complained, "We get to do one science lab each semester if we're lucky. Our school just doesn't seem to have the stuff it needs."

The professional staff are usually qualified generalists, but they may not have the great depth of understanding required to meet the expectations of these students. A seventh grade girl said, "Most of my teachers are afraid of me. They think I'm, smarter than they are. So they just let me do whatever I want to."

Only one student in one hundred scores in the 99th percentile on standardized tests. In many small districts, this fact translates to only one, or sometimes two students, functioning at this level in an entire grade. The students we encountered in our project are not textbook "Geeks", but instead they are well rounded students involved in extracurricular activities. However, they often feel uncomfortable or embarrassed by their giftedness. They lack role models. Many such students, even those students involved in sports and band, feel isolated and unchallenged. As one 9th grader, who is currently enrolled in Algebra II, put it, "Most of the time I'm bored out of my

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skull." As another ninth grader, who is enrolled in Geometry and is tutoring seniors in her class, said, "Tutoring is neat. I get to know other kids that way. But I don't really belong with them and I don't really belong with my class either. I guess I don't belong anywhere but here" [S.C.A.M.P.]. An eighth grade boy said, "Being smart is tough. Everybody always expects you to be perfect. Any time you're not, you're laughed at. Sometimes you're laughed at even when you do get things right." Another 9th grade boy, who is in sports and orchestra and seems quite popular, said, "I have to lead two lives. I have to watch every word I say and every thing I do to be sure it's considered cool. I can't ever talk about things I want to or do something just for the challenge of doing it. I can't let people know how smart I am. Otherwise, my friends won't accept me any more."

Many students exist in communities where educational and vocational horizons are very limited. Students we encountered from the coal mining regions and fishing villages alike do not see scientists at work. Many of these bright students don't even consider the possibility of a scientific career. As one 8th grade girl put it, "At my school, they expect you to slide through, graduate, get married, and have babies. That's all."

Most of the parents we encountered feel a need to do more for their children than they feel trained or able to provide. They are willing to go the extra mile, but don't know which way to go. As an example of this commitment, even though applications were not distributed until late May because of the red tape involved in the transfer of the program from Illinois to Virginia, we received over 400 applications in three weeks.

With these problems observed in earlier work with such students, Project S.C.A.M.P. was developed.

Program Overview

Project S.C.A.M.P. (Science, Computer, and Mathematics Professions) is a program funded by the National Science Foundation (Grant No. RCD-9096228) to nurture the mathematical and scientific talents and interests of rural gifted students entering the 7th, 8th, or 9th grade. The specific goals of this program are:

1. to expose participants to the excitement and challenge of a career in mathematics and/or science
2. to provide interaction with role models in these areas, including women and minorities
3. to provide counseling regarding career opportunities in the field, the academic preparation necessary for such careers and funding possibilities, and
4. strengthen peer, family and school support for such interests.

The year-long program consists of a three week residential camp on the grounds of the University of Virginia during which the

students take computer-based classes in geometry and mathematical modeling using HyperCard and spreadsheets. Each afternoon, a Ph.D. from a different scientific discipline demonstrates an area in their particular field of expertise (e.g. a physicist demonstrating a nuclear reactor, an astronomer showing his observatory, and an engineer demonstrating computer aided design) and discusses what their particular career is like, opportunities in their area, and the academic preparation necessary for such a career. As a year long project, each student creates a computer simulation for a scientific topic of their choice with the help of a university mentor, and input from their teachers and classmates. Students also meet on three Saturdays during the school year. A mathematical modeling contest is conducted as a culminating activity during the following summer. Between these formal meetings, students communicate with one another, the camp staff, and their mentors through the use of a computer network. In addition, they each demonstrate their project to classes in their local schools, using a Macintosh SE-30 with Soft PC so that it can run MS-DOS programs as well as Macintosh programs. Sample lesson plans on mathematical modeling are also provided to their teachers for use with the entire class.

Mathematical Modeling

In order to generate or sustain the interest of adolescents in careers in mathematics or physics or other sciences, the student must become excited about that discipline. This objective can be accomplished, in part, by having the student actually experience the challenges of the discipline, interact with people who are excited about their profession, and discover that many possible barriers to their own involvement can be eliminated. This project, using the theme of mathematical modeling as an introduction to experiences in other disciplines, is designed to do precisely that.

The development and use of mathematical models is integral to scientific research. Recent technological developments have provided new tools for mathematical modeling including graphing calculators and microcomputers. The focus of this camp is to familiarize students with mathematical modeling and its role in many diverse areas of scientific endeavor. By exposing students to a variety of scientists and mathematicians using mathematical modeling in their work, the camp will stimulate interest in science disciplines as possible and realistic career choices and make the students aware of the academic preparation necessary for such careers.

The National Council of Teachers of Mathematics' recently released *Curriculum and Evaluation Standards for School Mathematics* notes that

> The curriculum must give students opportunities to solve problems that require them to work cooperatively, to use

technology, to address relevant and interesting mathematical ideas, and to experience the power and usefulness of mathematics (NCTM, 1989, 75)

NCTM further recommends "actively involving students individually and in groups in exploring, conjecturing, analyzing, and applying mathematics in both a mathematical and a real-world context" (p. 72). It also calls for increased attention to real-world applications and modeling (p. 126). Of course, mathematical models are merely mathematical descriptions of real situations usually involving some simplification and assumptions.

The 1990-91 Program

Because we assume that most of the camp participants will not have some of the knowledge and skills needed to create models, in the first phase of the project we provide classes four mornings a week in order to provide the knowledge and develop the skills necessary. Three series of classes are conducted. One focuses on mathematical modeling and its tools such as spreadsheets and function graphers. Another class introduces computer programs which can be used to create simulations such as HyperCard. The third is a manipulative and activity based approach to geometry employing Logo and the Valiant Turtle (a robot under the remote control of the computer), and the Geometric Supposer series. The objectives of including this segment are to explore the role of assumptions in mathematics and the difference between conjecture and proof as well as to provide remediation for an area of perceived deficiency.

The students each take all three classes, divided into three sections of ten or eleven students each. Each section has an instructor and an assistant. There is one computer for each student. In fact, as each student checks into camp, s/he is issued a IBM portable computer, which is hers/his for the duration of the three week experience. The LOGO and spreadsheet work is done on these computers. The remainder of the work such as the HyperCard simulations is completed on Macintosh computers.

Most afternoons, students interact with specialists from specific disciplines. These researchers, many of whom later serve as mentors, talk about or demonstrate an area in their particular field of expertise with specific time allotted for questions. They explain what their particular career is like, opportunities in their area, and the academic preparation necessary for such a career. The 1990 schedule was as follows:

Monday, July 30
Dr. Larry Richards, Director, Manufacturing Systems Engineering Program; Associate Director, Center for Computer Aided Engineering
"What's the Difference Between a Scientist, an Engineer, and a Mathematician?"
Also a hands-on tour of the Center for Computer Aided Engineering

Tuesday, July 31
Dr. Charles Tolbert, Associate Professor, Astronomy Department
"A Night in the Life of an Astronomer"
Also a tour of McCormick Observatory, followed by star-gazing at the Observatory on Friday evening

Wednesday, August 1
Dr. Paul Reynolds, Jr., Associate Professor, Computer Science Department
"Parallel Discrete Event Simulation, Using Queuing Networks as an Example Application"

Tuesday, August 7
Dr. Robert Mulder, Assistant Professor, Department of Nuclear Engineering; Director, Reactor Facility
"Nuclear Energy - The Theory and the Reality"
A tour of the University of Virginia Nuclear Reactor

Wednesday, August 8
Dr. Louis Bloomfield, Assistant Professor, Physics Department
"Lasers: How Do They Work?"
A demonstration and tour of the Laser Laboratory

Thursday, August 9
Dr. Otto Friesen, Professor, Chairman, Biology Department
"A Computer Model of Animal Locomotion: Leeches"

Monday, August 13
Dr. Joe Garafalo, Assistant Professor, Department of Curriculum, Instruction, and Special Education
"How to Solve a Problem"

Tuesday, August 14
Dr. Donald Ramirez, Associate Professor, Department of Mathematical Sciences
"A Problem in Probability"

Wednesday, August 15
Dr. Karen Parshall, Assistant Professor, Mathematics Department and History Department
"A Historical Perspective of Solving Higher Order Equations"

Friday, August 17
Dr. John Jackson, Medical Educator, UVa Medical Education Center
"Interactive Videodisc Simulations in Medical Training"
A Hands-On Demonstration

Fieldtrip Schedule

On Thursday, August 2, participants toured the Information Age Exhibit at the Smithsonian Institution. They used a study guide prepared by one of our staff. A discussion on ethics followed. Campers also visited the National Air and Space Museum and viewed the movie "To Fly!" On Monday, August 6, participants visited the National Aeronautics and Space Administration Research Center at Langley. They toured the public galleries, listened to a talk about the facility and N.A.S.A.'s mission and a talk on job opportunities with N.A.S.A.. The N.A.S.A. personnel made special arrangements for our students to experience the flight simulator, and to see a computer graphics demonstration. The Structural Engineering Division showed the students the simultaneous equations for the mathematical model for stress on a section of an airplane wing, the computer graphics representation of the same thing, and the physical model upon which they were both based. A discussion on modeling followed. On Thursday, August 16, participants toured the IBM Research Center at Manassas Park where they saw computer chips being manufactured and heard presentations by a college intern, a female programmer, and a minority engineer on what their training and careers. On the way back to Grounds, participants visited the Shenandoah National Park for a program on "Birds of Prey" and a picnic to which parents were invited. In this way, our students were able to interact with scientists in their work places, both in the public and private sector, in a setting other than a university campus.

The Simulations

By the middle of the second week, participants began choosing the particular topic for a computer simulation of using HyperCard and a particular faculty mentor to serve as a guide, facilitator, and subject matter expert. Students are encouraged to work in pairs or even trios on a single simulation. Daily work time is available for meetings with mentors, team meetings, work with instructors and lab aides who serve as resources on technology and modeling. Work on these simulations will continue throughout the year, and be presented during the follow-up week in June.

Some of the topics chosen by this year's participants include: Endangered Species, Wing Loading of Jet Aircraft, The Space Shuttle, Comets, Planets, Dissection of a Frog, Electric Cars, Design Your Own Sports Car, Dreams, Left Brain Vs. Right Brain, and Future Shock.

Follow-up Activities

In order to sustain the interest generated by the three week summer session, several activities are continuing throughout the year.

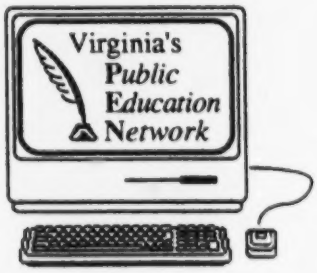
Project Demonstrations in Their Home Schools

As part of the follow-up activities, during the following academic year, two Macintosh SE/30 Hard Drive 40 microcomputers are being

loaned, on a rotating basis, to the campers. The campers can then share some of the knowledge and skills acquired during the previous summer with their teachers and peers. As part of the application process, the principal of the student's home school signed that they were willing to allow the student to demonstrate their projects and give an overview of mathematical modeling in a science or math class. In this way, we hope to obtain positive recognition for the student and expose both his teachers and classmates to some new ideas.

Virginia PEN

The Virginia Department of Education is establishing a Public Education Network (Spagnolo, 1990). This system will connect approximately 2,000 Virginia schools in 137 school districts to the existing national inter-university computer network, or *Internet*. The Internet in turn links tens of thousands of academic sites and industrial locations around the world. When it is completed, a single seamless telecomputing network will link all Virginia schools from kindergarten through graduate school (Bull, Hill, Guyre, and Sigmon, in press). To emphasize its use as an instrument of communication, the network has been given the acronym of *Virginia's PEN*.



The network has conferencing capabilities that potentially have great instructional value. Virginia's PEN has a conferencing system which supports use of *news groups*. There are three types of news groups: national, state, and local. There are more than 800 national discussion groups. There are thousands of sites which participate in the national news groups, including most major universities, government agencies such as NASA, and commercial firms. National news groups are organized by categories, such as science, societies, computers, and recreation. Each category has subcategories. For example, some of the listings under science include biology, chemistry, physics, mathematics, and space.

A special category of news groups has been established for Project S.C.A.M.P. on Virginia's PEN. Students may interact with one another, the S.C.A.M.P. staff, their mentors, and other resources such as NASA engineers. This link provides students with access to many human

resources, both academic and emotional, that they wouldn't normally have.

The Saturday Programs

During the following academic year, three Saturday meetings are planned. The first of these was held on Saturday, November 10. Participants shared their experiences in their home districts and also brought their solutions to a modeling problem that was sent to them approximately one week prior to the meeting. They also continued work on their simulations. On February 9, participants gathered on the UVa Grounds for a similar meeting. In addition, at this meeting six UVa first year engineering students met with small groups of campers to discuss a design project. The engineering students are designing a educational toy for 12-14 year old students to try to interest them in science or engineering. The campers brainstormed with the engineering students. The engineering students, in turn, answered questions about college, the application and admission process, and preparation for college. Thye campers and their families completed their day by attending dinner and a UVa Women's basketball game. This social activity also allowed parents the chance to compare notes. Students will meet at Virginia Power's North Anna Plant on Saturday, April 27 to tour their nuclear, solar, and hydroelectric power plants. These three days are planned to help maintain interest over the course of the school year, and judging by the high attendance rates, have been successful in doing so.

Summer, 1991

On June 16, 1991, students will arrive on campus to begin a week of activities which should provide a suitable culmination to the year's study. They will finish their simulations and present them at the end of the week. The students will also meet with UVa staff from Career, Planning and Placement to explore how to choose a career and prepare for college. In addition, on Monday and Tuesday, modeling techniques will be reviewed and practiced. Participants will be divided into three or four person teams for a modeling contest. Ground rules will be explained and the problem posed Wednesday morning. Complete solutions will be due by 5:00 pm Thursday. Staff will act as resources, but will not participate in the actual problem solving. Dr. Charles Straley, a Presidential Awardee, will create the modeling problem and serve as the judge. Students will demonstrate their solutions on Friday, a general debriefing will be held, and plans for the future will be discussed. After dinner, the camp will end with an open house for parents and an awards ceremony.

Assessment

Project assessment is on-going. Academically, participants were pre-tested and post-tested to determine their van Hiele level of geometric understanding. All students showed progress, with several moving one or

two van Hiele levels. All but one of the participants indicated that they would participate again if given the chance. Written evaluations from participants indicate the strengths of the camp include: the advanced subject matter, the opportunity to interact with real scientists and mathematicians, the quality of the teaching staff, the facilities, the fieldtrips, and the opportunity to meet and work with other gifted students. According to the students, the weaknesses of the camp were the food (a complaint typical of any camp which wasn't really justified in this case) and the strictness of the staff. (Students were not allowed out of the dormitories unescorted. They looked on this as being overly strict. We viewed it as prudent.) Feedback from parents support our level of supervision. The support from parents has been strong. Many have met with their children's teachers and have expressed their pleasure and that of the teachers at the amount that their children learned at the camp. They are pleased at the role models and support group for their children that the camp staff and participants provide for their children. They appreciate the career counseling. Dr. Mason has been invited to visit most of the schools and many of the homes of students during the school year.

Conclusions

Academically talented students attending rural schools have many problems to face such as isolation, unchallenging curriculum, and a lack of resources. The model of delivering supplemental services as implemented in Project S.C.A.M.P. appears to provide some solutions to these problems.

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